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from the CALIFORNIA MEDICAL GAZETTE, October, 1868.]

HYGIENE,

AS REGARDS THE

Sewerage of San Francisco.

BY

ARTHUR B. STOUT, M.D.

SAN FRANCISCO:

A. ROMAN & CO., PUBLISHERS,

Nos. 417 and 419 Montgomery Street.

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HYGIENE,

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THE SEWERAGE OF SAN FRANCISCO.

SEWERAGE is the mechanism by which the SEWAGE
of a city is removed.

EDITORS CALIFORNIA MEDICAL GAZETTE:

We propose, with your assent, to devote a few articles to the discussion, in your journal, of the important question of the system of sewerage now in use in this city. The defects of this system are an active cause of disease. The foul emanations from the sewers carry many a strong man, many a fair woman, in the bloom of health, and still a larger proportion of young children, to a premature grave. Even though the injury to health were less destructive, the offense which smells so rank, forcing all who walk upon the streets to inhale the sickening gases of such pestilent putrefaction, is an insult to civilized humanity. Such an offense would justly revert upon the municipal government, if tolerated after the remedy shall have been suggested.

While all minds have been alarmed from the fear of cholera; while sanitary measures are loudly called for, to clear away superficial nuisances, of very secondary consequence; while pamphlets are published and nostrums invented to cure the cholera; while quarantine exactions are proposed, to arrest the march of the dreaded pest from Asia, *via* Panama, or China; while the city's estimable health officer is hurrying from street to street to combat selfish and reckless landlords or tenants, recommending new sewers *ad infinitum*, and regard-

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less of cost, there are few who perceive that the most fertile source of cholera, malarious and epidemic fevers, small-pox inclusive, and scores of contingent diseases, is to be found in the mismanagement of the sewerage of the city.

There is little need to look to Asia for our cholera; we have an efficient and active manufactory of the article in our very midst; and every new sewer built under bad regulation goes to "pile on the agony steeper."

A thoroughly organized system of sewerage is indispensable to all large cities. Previous to the adoption of a process of drainage, at enormous expense, in Paris and London, the ratio of mortality by endemic typhus and typhoid fevers was vastly greater than that of the present report. By the construction of those immense works, public sanitary institutions have required less outlay, and countless citizens have been spared the expenses and losses incident to sickness, as well as the pain of death. If such statistics could be calculated, it would appear that tax-payers would realize a great economy, irrespective of the comfort of pure air to breathe, by maintaining a perfect sewerage, no matter how great the cost of construction. It is, however, more requisite in the conduct of such a system, to observe a perfect discipline in its daily working, than in its primary construction. In vain may engineers construct the mechanism, if afterwards the trustees neglect and mismanage. Herein it is that the authorities sin. Were even the sewers we have properly cared for, a city of only seventeen years' existence, daily ventilated with the pure air from the ocean, would not resemble, in its noxious effluvia, such old and crowded cities as Paris and London, before their sewerage system was introduced. Be this as it may, we have before us, in London and in Paris, the lesson of the almost incredible expense incurred by the neglect of due precautions to protect health in earlier years. Let us then accept the costly hint, and establish the best system which can be devised, while yet the city is young and small. Already the grievance of narrow streets is calling for and receiving reform. Let underground and street improvements, which concern the general welfare,

progress *pari passu*, in equal movement with the admirable improvements of private enterprise. What will avail your elegant superstructures, if the underworks and foundations are unhealthy and unsound. The malarious exhalations which generate endemic maladies, as they exist in San Francisco, by their continuousness, their insidious gnawing into the life source of health, or in other terms, by tainting through weakly poisoned air the atmosphere which enters the lungs for human respiration, hurry on to early graves more individuals in two years than would an invasion of Asiatic Cholera, with its demoralizing influences, in as many months. The action is slower, and from the apathy which slowness begets, still more certain in its deadly influence.

In order to estimate justly, not the merits but the demerits of the sewerage, as now conducted, it is desirable to explain the present system; then criticise its working; and finally, indicate the remedy.

Through all the principal streets, large brick sewers are constructed, measuring 3 ft. by 2 ft. inside measurement, and 1 foot in thickness. These sewers descend to the bay, with a dip as favorable as the lay of the land and the grade of the streets will permit. This dip, however, in the low portions of the city, is very slight, and in some places quite insufficient for quick drainage. Along these sewers, at certain intervals, large openings, or man holes, are built, to permit men to enter and clean out the accumulated mud and ordure. At the corners of the streets other openings, called traps, are constructed, that surface water, rain and street washings may enter. These traps are ingeniously built, with a central partition to form a water valve, which prevents air in the main sewers from escaping in the streets, while the street water may enter freely into the sewers. The action of these water valves is excellent while the traps are kept in order. When filth accumulates, however, the water is driven out of the valve, and a putrefactive mass is gathered in the bottom of the trap, through which the gases in the sewer can permeate, and infect the streets. To free the traps when they become clogged

men are employed to shovel out this putrid mud, as may be frequently seen at the street corners. Large piles of this mud, which the sewers are constructed to carry off, never to be seen again, nor smelt, after once entering them, are strewn upon the street for hours, disseminating putridity and disease, until other men with carts shovel it up again into their vehicles; thus, by dividing it up, giving it a thorough ventilation, as though to sanify it, and again whirling its noxious effluvia into the air, and the noses of the faithful tax-payers, who pay so dearly and yet so cheerfully for the epicurean privilege. Aye, the open cart carries away the mud, scattering far and wide its baleful aroma; the nose absorbs the flying pestilence; and by and by another vehicle solemnly removes a victim of a wretched and pernicious system.

All the sewers, as thus described, are intended to empty their contents into the bay along the wharves at North Beach, in Mission creek, in Islais creek, at South Beach, and so on, as the natural inclines of the soil permit. Does the result fulfil the intention? We will presently show.

To deprecate that which exists when no improvement is offered, may be considered unworthy; but if the propositions advanced are not fairly sustained, then let us receive the punishment due to our temerity. Having thus given a general idea of the present system of sewerage, its defects will soon appear.

Of what avail are these vast brick canals under the city? Their immense cost is already realized by land owners, and can be rendered only more apparent by statistics. During the months of drouth very little water, but the waste of the water companies and the washings of houses, enters. This quantity is insufficient to wash away the accumulations. It is still worse in the traps, which are quickly clogged, and which, without a constant supply of water to form the water valve, become outlets for effluvia throughout the city. Were it not for the winds from the ocean, this fault in the sewerage would render the air insupportable. At night, when the atmosphere is at rest, the odors from the street corners are still more per-

ceptible. The insufficiency of water in the main sewers permits their contents to mingle with sand which enters them, and form a thick paste, which moves sluggishly forward, or is entirely detained. Thus putrefaction has ample time to generate foul gases. These, of course, occupy the upper portion of these large canals, which conduct them most effectually throughout the city. As the water flows downward, the counter current of gas receives a pressure which forces it rapidly upward. An exit it must and will have; return it cannot, and consequently it finds its way through the lateral pipes and drains into the houses. It rises to the highest elevations of the sewers; and in that manner the high lands, which are selected for their healthfulness and freedom from malaria, become as much infected as the low grounds of the city. In every residence where the lateral sewers are neglected, or unprovided with traps or water valves, the noxious odor penetrates, often to a degree to produce nausea and vomiting to the occupants of basements. This is the fruitful source of fevers, putrid sore throats, and many eruptive diseases. Were the main sewers provided in all seasons with an ample supply of water, their accumulations would be rapidly washed to the bay, and putrefaction have no time to establish itself. At no time are these vast sewers more than one-third occupied by sewage, seldom as much; the remaining two-thirds is filled with the gaseous products of putrefaction. We have shown that these would be greatly diminished if the sewage matter were carried off faster; but being produced they would be rapidly forced out of the way, if two-thirds the calibre of the sewer were not provided for their accommodation.

The only apparent reason for these immense subterranean channels is to allow men to enter and clean them; but a rapid stream of water obviates this necessity.

The outlets of the sewers are often uncovered at low tide, and the discharge from them spreads far and wide on the shore, exposed for several hours to the sun, while awaiting the flood-tide to wash them away. Thus is created a new source of infection. The air in the sewers being warmer than the external atmosphere, ascends the sewer, while the air from

without follows. The gases, therefore, receive another impulse besides that already mentioned, and are injected through the side pipes into houses and the elevated portions of the city. Happily for us, then the sea breeze comes to our aid and fills the role of scavenger.

Imagine every street of this widely expanding city channelled beneath with brick cylinders, two-thirds of whose area is filled with blood-poisoning effluvia, which circulate under pressure, and find egress into the atmosphere through every orifice, every leak, and every pore. A foot thick wall of brick and cement does not restrain them. Out they must, and if no outlet is given they will permeate the wall and transpire through the soil. These cylinders act like retorts and generate the vile gas from their own obnoxious contents. Imagine then this vast distillery of pestilence seething its vapors beneath your soil, beneath your houses, beneath your beds, evolving them day and night without intermission, intoxicating every breath you inspire with a fractional dose of poison. You will begin now to comprehend why a sudden congestive chill has destroyed in an hour or a day some young and beautiful woman in the joy and bloom of life. You will perceive why some hale, strong man, who has received some injury from which his natural strength would enable him easily to recover, is suddenly seized with rigors or chills, followed with a raging fever, and perhaps erysipelas, and in a few days dies, or is rescued with difficulty. Again, you will understand why little children of unexceptionable parentage, in the perfection of health, clothed with perfect propriety, nourished in the best manner with the most careful choice of food, are suddenly seized, perhaps in the night, with cramps, with inflamed throats, with convulsions, and in a day or two are borne to the cemetery. Why should such children, with perfectly normal constitutions, enjoying without stint a wisely directed physical education, defeat the law of nature and prematurely die? It is because a poison has been inhaled into their blood through the lungs, which has slowly and insidiously intoxicated the vital fluids and the brain, until the sys-

tem becomes fairly saturated, and then follows the sudden explosion of disease, and rapid death. The vital fluids have become altered by a contamination which parental solicitude has neither perceived nor understood, until death's climax is at hand, and medical skill, however rationally applied, has no time to alter the fiat. The other minor causes of children's disorders are incompetent to work such havoc in so short a period.

The assertion is not advanced that all such occurrences depend upon the sewers. This peninsula was subject to malarious diseases before those indispensable canals were laid. But natural miasms of the soil bear no ratio to those artificially engendered and propagated by a badly organized sewerage. Hence is the increase of mortality in a greater ratio than the natural increase of population. As we sow we may expect to reap; but it is discouraging to be answered, when we venture to boast that the improvements in medical science have increased the average length of human life, that the mortality record proves the reverse. Of what avail are improved surgery and more enlightened medicine, when another enemy, of man's own creation, enters the field to make impotent our skill.

The construction of these immense canals, called sewers, is conducted according to a statute or arbitrary ordinance, which leaves to the Street Commissioner very little room to exercise his own discretion. The ordinance is inexorable, and sewers are laid in small streets of the same dimensions as in large ones. There are alleys whose perfect sewerage could be obtained with twelve or eighteen-inch pipes, and oftentimes by dipping from the center of the block both ways to the adjoining streets, might be placed nearer the surface. The diminution of time and expense must be apparent. But no; a great putrid gas chimney must be laid, to retain and distil the pestilence.

THE REMEDY.

Costly as may be the remedy of these evils, it has become indispensable to the public safety to seek for and apply some curative process. The public health is the most eloquent

appeal to the tax-payer. With the new system to be proposed, the heaviest expense is in the first inauguration; after which we hope to show that a great diminution of the current expenses will follow, and the enormous sum saved in the construction of the sewers will in the end effect a decided economy.

The great remedy for all this distress is water, and the mode of its administration is the cure. Irrigation in abundance, incessant both in summer and in winter, applied under a system of perfect discipline and continual watchfulness, will deluge the nuisance, and wash it to the sea before it can become an instrument of misery and death. Fresh water from the water companies is too scarce and too dear; but salt water in abundance is in the bay, and costs nothing but the trouble of its use.

There are two modes of application: Firstly, to construct reservoirs upon properly chosen elevated places, and with steam-engines pump up the water, and thence distribute it into all the sewers. Pipes may also pass through the sewers, which pipes, supplied at intervals through their course with irrigators, and constantly discharging jets of water, would effectually prevent the formation of accumulations or clots. The reservoirs need not be large nor expensive, for as there is no object to detain the water, but to let it rush off as rapidly as raised to the proper elevation, only small tanks would be required. Or, secondly, the water might be injected directly through pipes supplied with irrigating jets, and running upward in the sewers. The objections to this plan would be the inequality of the pressure on the pipes, and the inconvenience of their bursting in the sewers. The reservoir system secures greater evenness of pressure. Where there is no necessity to maintain large supplies of water, neither the engines nor the reservoirs need be of such great capacity and cost as those used in the hydraulic operations of the city of Philadelphia. If, however, such immense machinery and such vast enterprises are undertaken in Philadelphia and New York to maintain the public health, by supplying pure water for healthful

nourishment, why should not San Francisco protect its health by supplying clean water to wash away the causes of pestilence and disease.

The introduction of the water system cures in an instant the evil at the corners of the streets. An irrigator attached to every water valve or trap (water valve in their present condition is surely a misnomer, for they rarely receive any water), immediately cleanses the traps, leaves the water necessary to form the valve, and thus only can prevent the exit of gases. What, now, becomes of your men digging filth from the corners and the man-holes?—the heaps of sewage on the streets?—the open carts fanning the air with noisome stench? They all vanish, *presto*; the irrigator keeps these effluvia where they belong, and the rapidity with which offal is carried to the sea prevents its degeneration by putrefactive decomposition into pestilential vapors.

What would London pay for our facilities for the removal of offal? Elevated grounds for a head of water, every tidal wave giving streams of crystal water from ocean springs, the Golden Gate as discharge-pipe only a few miles off; and yet, those facilities, placed so easily within our reach, are disregarded.

To facilitate this copious irrigation, the aqueducts should be of a size to concentrate the offal, and enable the jets of water to play directly upon it. They should have a pitch, to obtain the greatest possible velocity to the flow of the stream. They should have abundant space for their contents to flow without exerting pressure upon them, and also room for some unavoidable gas; yet there should not be space for the volumes of gas which would be evolved from decomposing matter detained in the tubes; but as there should be no detention of the sewage, so, also, will there be but little evolution of the gas. Tubes of iron of eighteen-inch caliber would suffice for mains; or if, on trial, Skinner's sewage pipes prove sufficient, they offer advantages over iron or brick. They can be perforated smoothly to admit lateral tubes, and are cheap. Such aqueducts can be laid nearer the surface, and thus where the incline of the land is slight, a better pitch for the pipes be obtained.

Any one who will calculate the difference of cost in this process over the enormous expense of three feet by two feet brick sewers; the time, labor, and street obstruction they cause; will now discover the eventual economy. The new system, by requiring engines and reservoirs, appears to threaten the city with a new debt. It is shown, however, that there is economy in every step.

Another advantage to be derived from using small aqueducts, is the relief immediately given to the low lands where there is little or no pitch, as below Montgomery street, along Mission Creek, and in Hayes' Valley. The terminus of the aqueducts in the bay can always be carried into deep water, below low tide, and thus form a descent. The upper termini of the tubes are always in elevated places. When now the water descends with force, it must drive all the sewage in the horizontal portion of the aqueduct before it, until it meets the last descent into the bay. Again, as the outlet in the bay is always submerged into deep water, there will be no accumulations of black putrescent filth along the shore, nor effluvia to infect the air.

As regards the upper termini of the sewers, an apparatus can be attached to them by which all the gases in the tubes may be rapidly attracted upward and be consumed. By finishing the aqueducts with a horizontal cylinder of iron, which passes through a furnace and terminates in a chimney at right angles to it, a powerful upward current of air will be established, and be burnt as it passes through the heated retort. As the retort merely passes through the furnace, these fires may be made useful for various purposes in the arts.

Another source of income to diminish the expenses of this system may be derived from the reservoirs. These bodies of water can furnish power for turbine wheels, and thus promote many industries which do not need much motive force.

In order to derive the utmost benefit from the reservoirs, and as an extra precaution to prevent the water valves at the street-corners from becoming obstructed, hydrants might be placed at these openings connecting with the main aqueducts.

Every two or three days an inspector should allow the water valves to receive a thorough washing. These hydrants may subserve another purpose—as street sprinklers they may lay the dust. In the event of large fires, the Nicholson and Stowe pavements, saturated with asphaltum, must infallibly burn, and by rendering the streets impassable, increase indefinitely the destruction of property. But if the streets can be flooded with salt water from the hydrants, these costly pavements may be saved. By using this expedient at fires, where the water by reason of its saltiness cannot do extra damage, the expense of fresh water from the companies may be diminished.

Having discussed as briefly as the great interest of a subject made up of many details would permit, the question of irrigation and the sewers, as they now exist in the streets, the great home question now arises: the protection of the individual houses, not only from the effects of the retained sewage within themselves, but what is worse, the introduction of the poisonous gases from the main sewers of the streets.

But few observe that while they free themselves, at small cost, of their house and kitchen waters, through wooden canals under their tenements, that, they are introducing a worse nuisance than the one they banish. From the very handy construction of these tubes, while they let a little stream of water out, they let a strong current of air in. The water companies and the gas companies watch with scrupulous economy any leaks or defects in their pipes, because every cubic foot of gas or water lost has a specific value; but the gases and waters from the sewers, being rated as of no account, are cared for by nobody. But that they are of immense account to somebody the mortality report is daily proving. The apparatus of sewerage should be as much a work of precision as the mechanisms which enter well-conducted gas and water works. And if municipal authorities do not possess the energy, or think it undignified, to establish and incessantly watch such a system, it should be handed over to the tender mercies of a monopoly to profit by it.

Not a house, not a tenement should be unprovided with sewerage, properly managed and frequently inspected. There is no longer an apology for neglect. Landlords and tenants have both their health, money, and lives invested in the institution, and are alike responsible for the public safety. Usually the landlord throws the expense on the tenant, while the tenant throws back the shuttlecock upon the landlord, and meanwhile nothing is done. Something is done; the public and the press call aloud for better health, and the invalids say: "but doctor, why am I always sick? why does my malady relapse?" is there, then, no *permanent* cure?" The profession answer: "No, ladies and gentlemen, because your blood is freshly poisoned every day, and the action of antidotes is not *permanent*."

To counteract, then, as far as may be, the infection of houses, water traps should be made in every conduit from the house to the main sewer. This precaution is easy now, for there are patent, cast-iron garbage boxes, with water valves, which should be placed in every lateral sewer. These apparatuses are exceedingly efficient, and are provided, or should be, with movable galvanized iron filters to separate the solid from the liquid offal. These contrivances are cheap, and everybody should buy them. Unless, however, frequently inspected, they are neglected by reckless people, and the water is allowed to dry out. This is especially liable to happen in untenanted buildings. It is not difficult nor expensive to obviate such accidents by constructing somewhere in every lateral sewer, a wooden box water valve, holding eight or ten gallons of water. Thus, a box is planted in the ground, in some easily accessible place. The sewer pipe from the house enters this near the bottom; the discharge pipe to the main has its outlet near the top of the box; between, of course, a small lake of water is formed, through which the gases from the streets cannot pass. Again, into the upper part of the box introduce the rain gutter from the roof of the house. During seven months of the year the rain thus introduced keeps perfectly washed the water valve. No gases can collect, for the rain pipe con-

ducts them all the year to the upper air. The large quantity of water these boxes contain, constantly changing, prevents their drying out, and is a guard valve which will amply repay its cost. The box should have a tight cover on hinges, to allow the inspector from time to time, once a week, to examine its condition.

The next important thing to look to is the *solid* offal, the vegetable and animal refuse of the kitchen. This should never be permitted to enter the sewer. The filter which separates it from the liquid garbage should be frequently emptied into a close receptacle and be daily removed. This substance is a fertile source of infection. It quickly heats, ferments, and putrifies. But nobody likes to smell it or to touch it. It is the grand bugbear of careless, indifferent, ignorant people. The more lazy they are to remove it, the better it punishes them when they must lose their sweet scented companion. Yet this substance is invaluable to form a rich fertilizer of the soil. Thousands and tens of thousands of tons of valuable manure are lost.

Let us suppose a perfect system of management. Early every morning the house barrel is emptied, before putrid decomposition begins. It is emptied into closely covered carts; and thus handled, all the horrid odors which we now daily perceive, from filthy, open, disgusting garbage carts, which may be scented a whole block while they stand lazily ventilating themselves on the street, will at once be prevented. The prevention of decomposition prevents infection. Let these vehicles now deposit their contents at some common rendezvous where they are forthwith disinfected, and then converted into *poudrette*. This method presents another source of income to defray the general cost of sewerage.

Will you seek another source of revenue for the same great object? The fire insurance companies pay large bonuses to protect their policies. Their gratuities to the fire department have been great. The marine insurance companies expend immense amounts in salvage, and in ship surveys, to guard their risks. In like manner let the life assurance societies contribute freely to the sewerage fund.

Should the registrar of vital statistics separate, if it were in his power, all the deaths caused by malarious infection from the mortality roll, and suppress, if it were possible, this cause of disease, the decline in the record of death, and the consequent increase in the average duration of life, would astonish the actuaries of life insurance companies, and amaze the general observer. It is to the interest of every individual to be able to obtain life assurance at a low premium. Surely, then, a city which diminishes, by its sanitary precautions, the ratio of deaths, should enjoy the privilege of a lower rate of premiums than another, which neglects the principles of hygiene.

The discussion of this subject is by no means exhausted; but to conclude, for the present, the hope is entertained that the vital importance of applying a radical remedy to the evil as it now exists, and which cannot fail to injure the character of the city for healthfulness, to divert the immigrant from the settlement he otherwise would be disposed to make, and even induce families to break up their homesteads, will induce the proper authorities to give it the study it merits.

The inauguration of such a system calls for a special department in the Engineer's Bureau of the city. The work is beyond the competency of a Street Commissioner elected by popular caprice. An engineer's department, endowed with power, and supplied with faithful assistants and deputies, possessed also of ample funds, is far more capable to conduct a system comprising elaborate details and cultivated knowledge in a great variety of the departments of science.



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